# Invisible Cones of the Pantheon

Kristin Jones

This essay focuses on one of the great wonders of the built world –the Pantheon, constructed around 126 AD– and, through drawing, proposes a possible clue as to how its form may have been generated in relation to human perspective. The oculus is interpreted as a lens, connecting the individual viewer to the infinity beyond. Between the circular opening above and the finite point of the observer below, an invisible geometry is formed: the cone. This central cone is understood as the building's generative DNA, closely aligned with the internal workings of the human eye and the stereographic cones through which we perceive the world.
In attempting to understand how such an accurate building could have been conceived and drawn in antiquity, this essay revisits scholarly research into the generation of the dome's coffering and hypothesizes that principles of stereographic projection may have informed both the coffers' geometry and the precise diameter of the oculus.
This essay forms part of a broader artistic body of work, beginning with three-dimensional drawings that explore the Pantheon's invisible geometries, the phenomena of time and light, and its connection to the beyond. Ultimately, the work aims to inform an ephemeral installation that juxtaposes the monumentality of the Pantheon with the fragility of human life.

## Introduction

The Pantheon, widely regarded as one of the most iconic monuments of the ancient world, remains enigmatic

*This article was written upon invitation to frame the topic, not submitted to anonymous review, published under the editorial director's responsibility.*

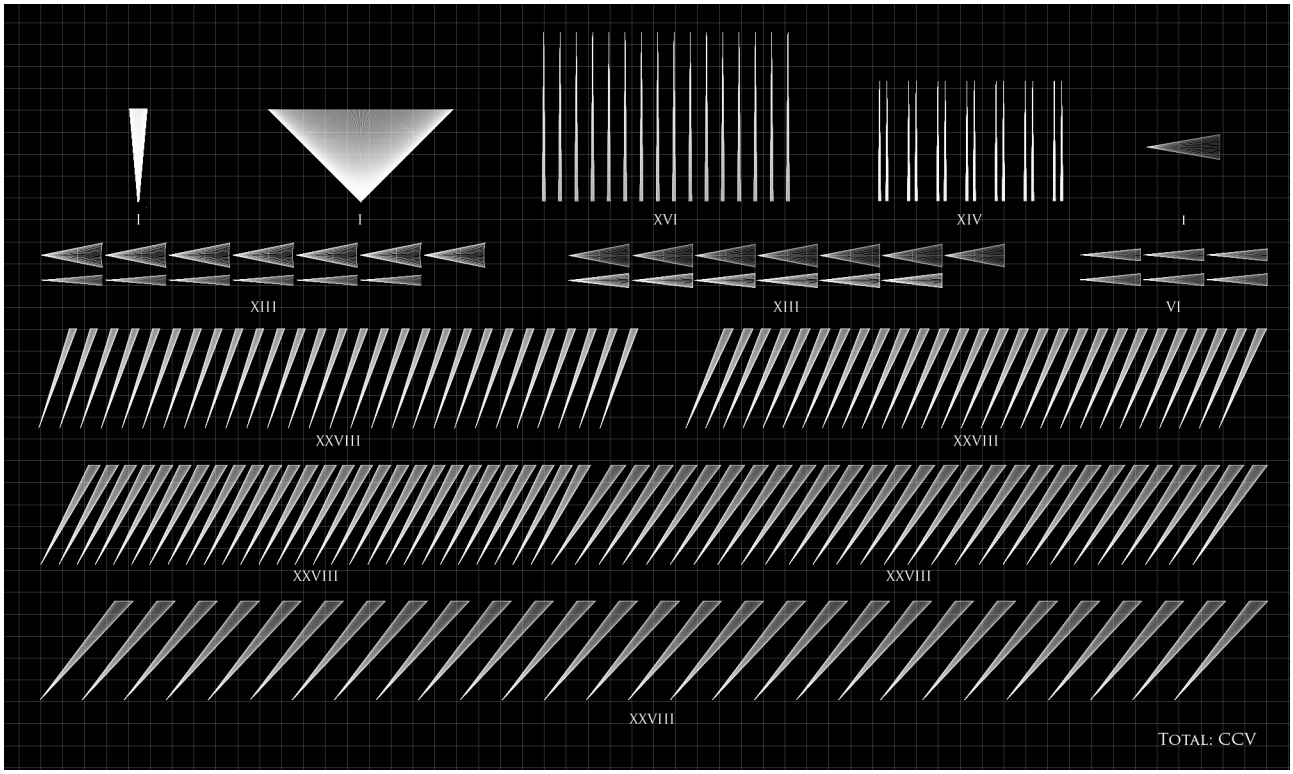



*Fig. 1. The 205 invisible cones of the Pantheon (diagram by Brooklyn Richardson, 2025).*

in many respects. Its unusual history, design, and construction continue to provoke scholarly debate. This artistic investigation addresses the relationship between the human eye and the building's geometry –beginning with the oculus (fig. 1). Central to the analysis is a hypothesis of architectural graduate Yuhao Jiang, made in collaboration with artist Kristin Jones for her project *Oculus: A Tribute to the Pantheon*, which suggests that stereographic projection may have informed the design and diameter of the oculus. Through a series of original illustrations by Jiang and others, the article visually examines the invisible presence of a cone embedded in the architecture and spatial logic of the Pantheon. It proposes that this conic geometry may offer an interpretive key to understanding the symbolic and optical intelligence of the structure.

## Geometry and *symmetria*

Key to the construction of the Pantheon is the core concept of *symmetria*, or mathematical harmony, employed by Roman architects [Marder, Jones 2015]. This idea was a cornerstone of classical architecture and involved the use of simple arithmetical ratios and round number divisions in the planning of buildings. The interior of the Pantheon is well-known for being as high as it is wide, consistent with the notion of an inscribed sphere or a

hemisphere on a cylinder of the same height. Elemental geometry also governs the construction, with the orthogonal parts of the building conforming to the figure of a cube interlocking with the sphere of the rotunda interior (fig. 2).
The geometry involved in the Pantheon's design also gestures towards the symbolic importance of the structure. As early as the third century, the vast dome was interpreted as a symbol for the vault of the heavens. Greek author Cassius Dio offers this opinion in his work *Romaiká*, writing on the source of the building's name: "The Pantheon is called so, perhaps, because it contains the statues of many gods, including Mars and Venus; but my own opinion is that, because of its vaulted roof, it resembles the heavens" [Dio, 53.27.2].
Furthermore, describing the view presented by the building's interior, Giangiacomo Martines, architect with the Soprintendenza Archeologica of Rome (Archaeological Superintendency of Rome), writes of the fundamental union of dome and cylinder presented by the rotunda, thus: "The only source of light, the oculus, draws the visitor to the center of the space, where we can wonder at the monumental interplay of a hemispherical dome resting on a cylinder of the same height, a geometry confirmed by modern precision surveys" [Martines 2015, p. 100].
The use of this geometric relationship in the Pantheon's design was no doubt informed by Archimedes' key work on the subject, *On the Sphere and the Cylinder*, written c. 225 BC. Here Archimedes includes key findings that the ratio of the volume of a sphere to that of a cylinder of equal height is 2:3, and also that the surface area of a sphere is equal to the lateral surface area of a cylinder with a height equal to the sphere's diameter and a radius equal to that of the sphere.

## The cone in the Pantheon

Once within the space of the Pantheon's rotunda, visitors raise their eyes to look through the oculus and into the sky beyond. This conic configuration of observer and oculus is illustrated in figure 3.
As humans, everything we see comes to us by way of the geometric form of the cone. Our stereographic field of view is quite literally understood to be conic in shape (fig. 4). While our current understanding of optics has little in common with that of the ancients, the concept of a cone of vision was recognized by writers of the Greco-Roman world, most notably by the mathematician Euclid and astronomer Claudius Ptolemy [Euclid 1945; Lindberg1976, pp. 15, 16].
This cone of vision gains further significance when examining the architectural geometry of the Pantheon, particularly in relation to the work of Amelia Sparavigna and Lidia Dastrù (fig. 5) and their 2018 pre-publication article *The Pantheon, Eye of Rome, and its Glimpse of the Sky*. Here, the scholars propose that "the architect who planned the temple had been inspired by the form of the human eye to create a building representative of the link between Rome and the heavens" [Sparavigna, Dastrù 2018, p. 1]. This interpretation suggests the oculus may be read as a symbolic eye –one through which the mortal viewer gazes upward with conic vision toward the divine expanse above. Within such a sacred space, the geometry becomes not only architectural but metaphysical.
As figure 5 illustrates, the almost nine-meter diameter of the oculus allows the viewer who stands in the direct center of the interior to see an angle of ten degrees wide. Given the placement and proportion of the oculus, the Pantheon functions as a zenith telescope, which allows visitors to observe a small section of sky directly above Rome by narrowing the expansive view of the heavens, allowing for a more focused and detailed observation of a limited portion of the sky. With this, using the astronomical simulation software Stellarium, Sparavigna and Dastrù were able to calculate which stars would have been visible to an ancient Roman looking up through the oculus at night [Sparavigna, Dastrù 2018, p. 4].
However, it is notable that when examining the Pantheon in a high-definition Lidar generated digital model, the angular slice of sky is slightly larger than ten degrees (fig. 6), because for the angle to be exactly ten degrees, the viewer's eyes would have to be at the apex of the cone –which lies on the floor.
Could this explain the presence of the curious bronze drain cover at the precise center of the floor that resembles an eye-mask (fig. 7)?
Corroborating the proposition regarding the role of the 'eye-mask' drain in the Pantheon's floor, research in visual neuroscience underscores the critical importance of the central 5 to 10 degrees of the human visual

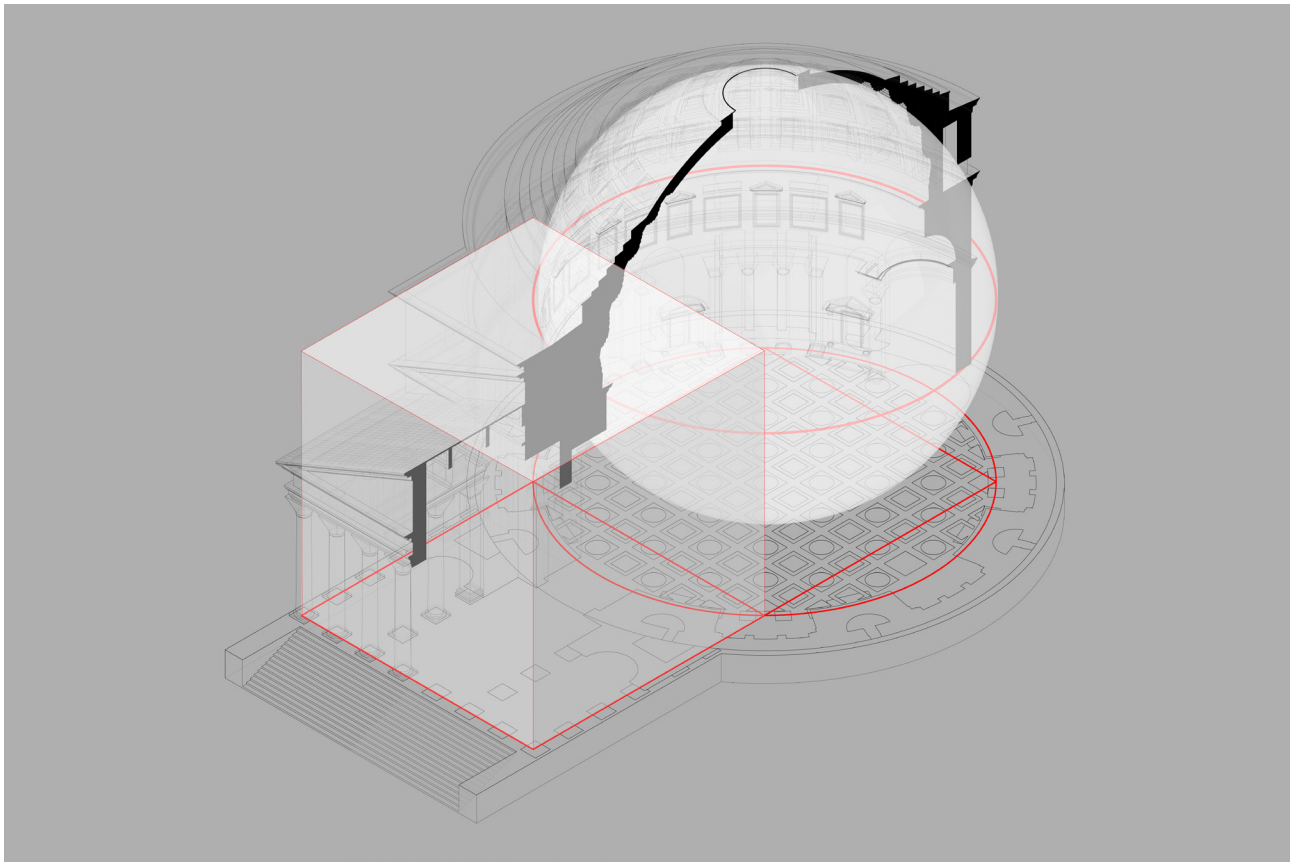


*Fig. 2. Geometric Analysis, after Mark Wilson Jones, redrawn by Yuhao Jiang.*

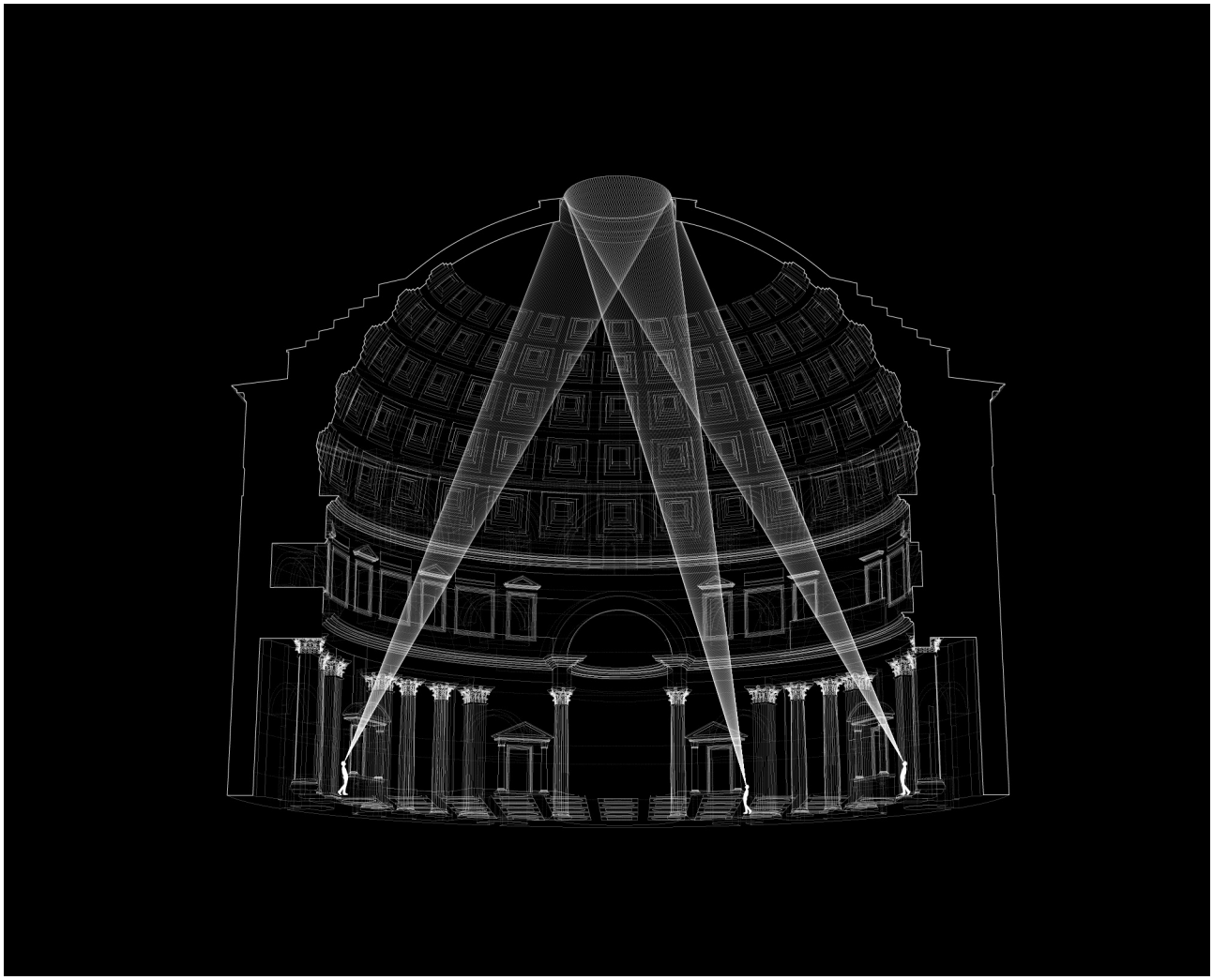


*Fig. 3. 3D Cross-section demonstrating three different visitors' perspectives looking up through the oculus. Drawn by Caleb Skene for Kristin Jones Studio.*

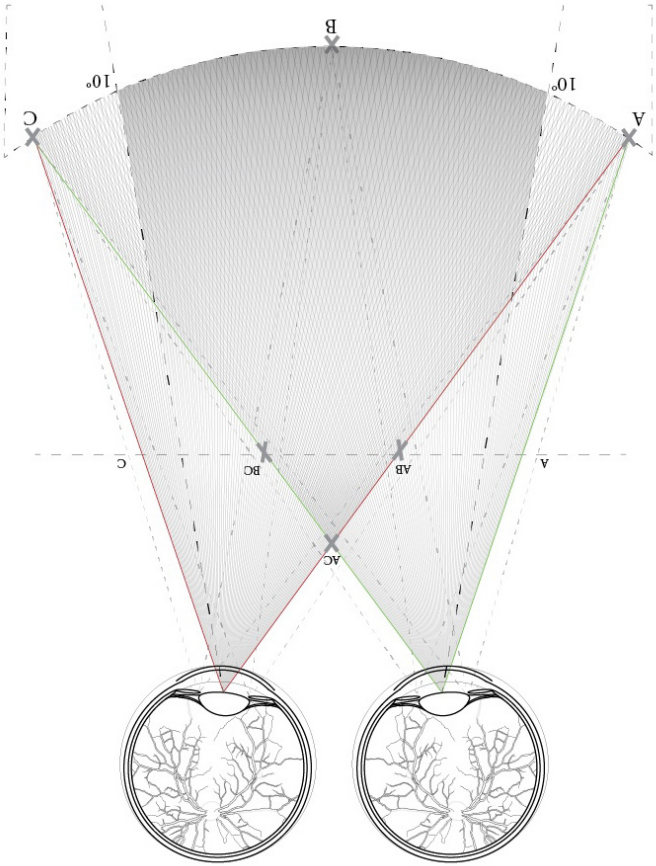



Fig. 4. Stereographic vision diagram showing left eye outlined in red and right eye in green. Drawn by Caleb Skene.

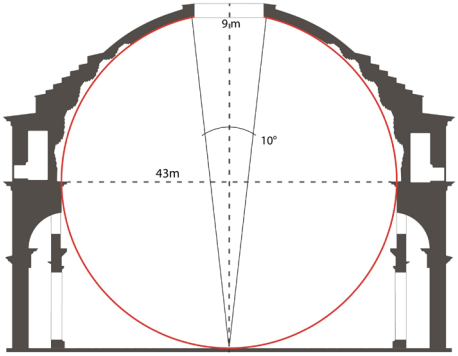



Fig. 5. Diagram showing the visible portion of sky through the oculus after Sparavigna, Dastrù, redrawn by Caleb Skene.

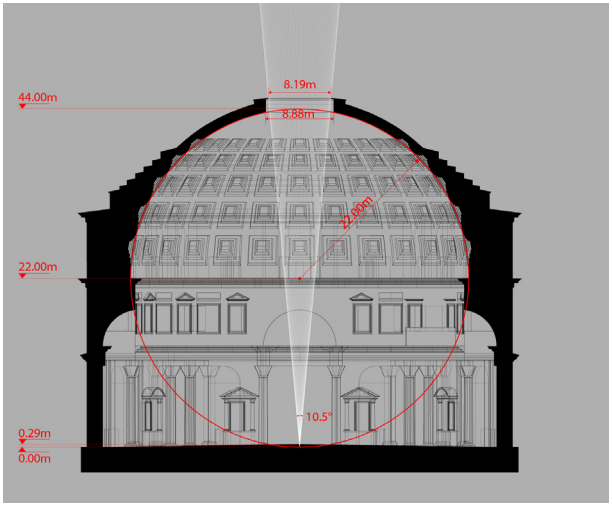



Fig. 6. Dimensioned frontal section showing the geometry of the cone projection into the sky through the oculus drawn by Yuhao Jiang.

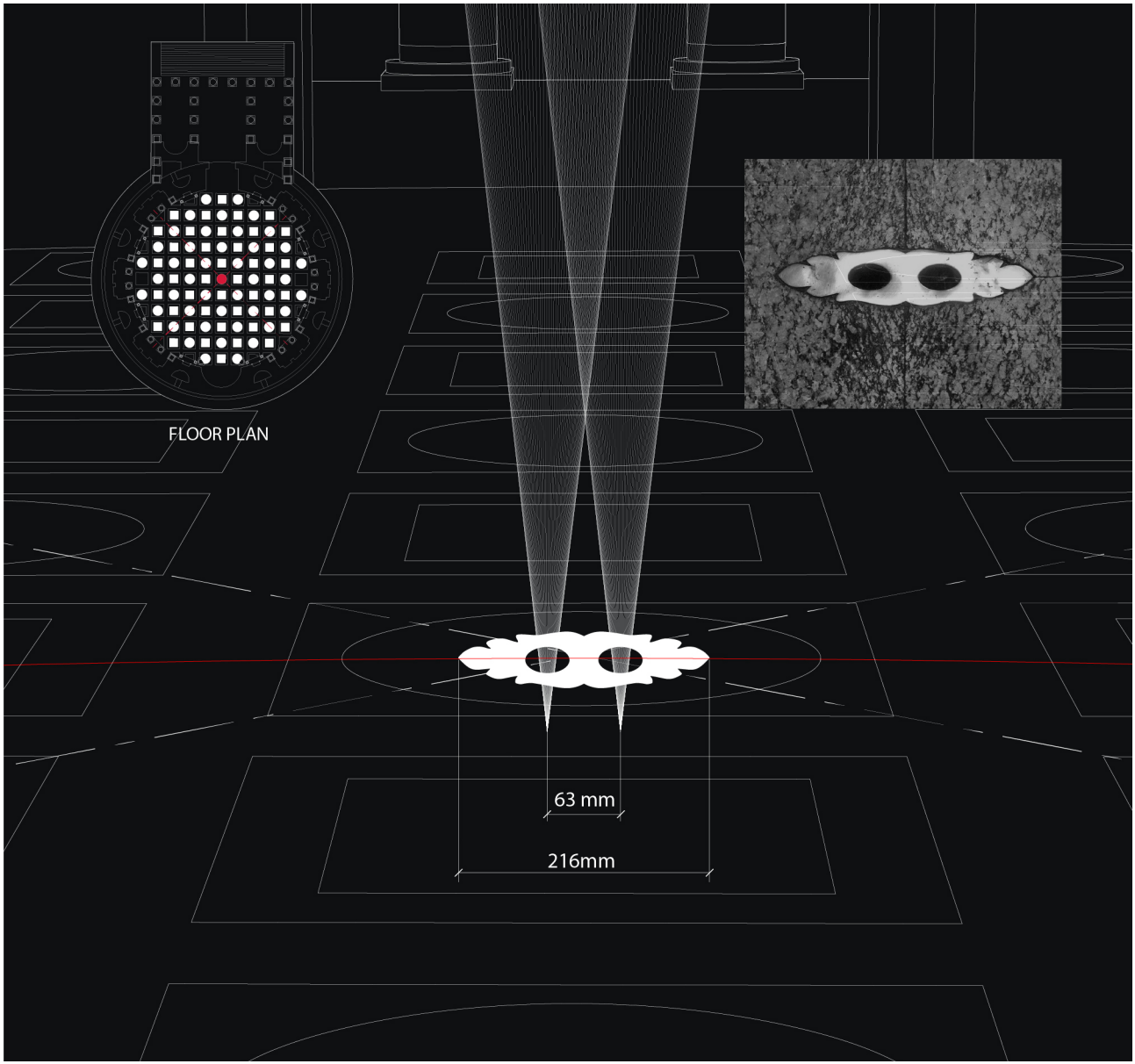



*Fig. 7. Diagram of Pantheon's drain cover hypothesized as a stereographic mask with two eye sockets. Drawn by Caleb Skene.*

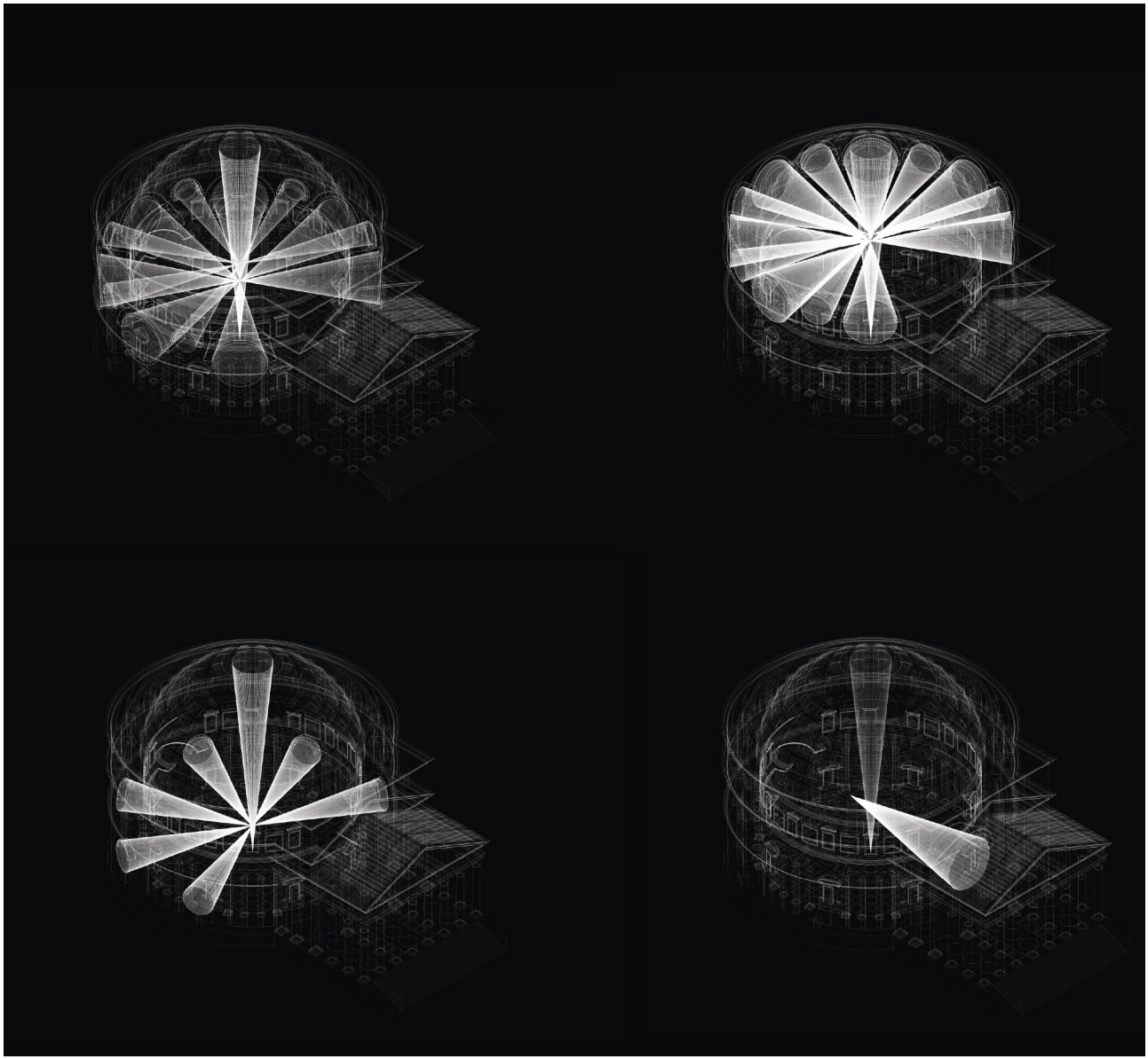


*Fig. 8. Invisible cones in the cylinder, generated by all the supporting arches, converging toward the vertical central axis as imagined by artist Kristin Jones and drawn by Yuhao Jiang and Caleb Skene.*

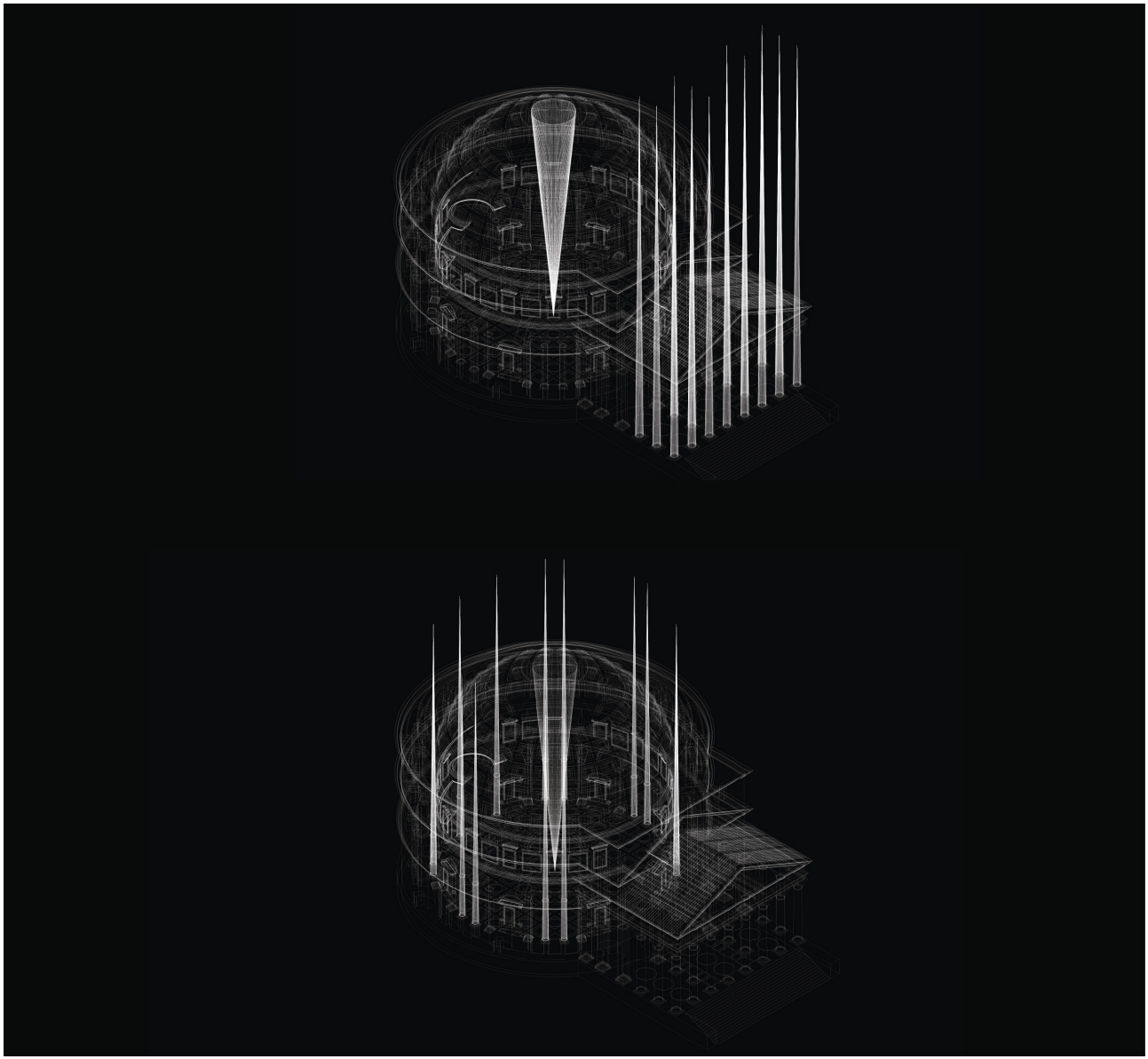


*Fig. 9. Invisible cones generated by the vertical taper of the columns as imagined by artist Kristin Jones and drawn by Yuhao Jiang and Caleb Skene.*

field –corresponding to the foveal and near-parafoveal regions– for detailed pattern recognition and high-acuity vision [Strasburger, Rentschler, Jüttner 2011]. This narrow conic field, where cone photoreceptors are most densely concentrated, enables sharp and focused visual perception [Curcio et al. 1990]. In the context of the Pantheon's oculus, this 10-degree cone of vision supports the idea that the architectural design may have intentionally framed the viewer's gaze from this central drain cover, channeling attention upward through this focused conic range to emphasize a precise and elevated connection between the observer and the celestial realm above [Silverstein 2008].
Although the intentions of the Pantheon's architect remain unknown, the symbolic equation of the Pantheon with the human eye remains compelling. This interpretation gains further weight when one considers that the Pantheon stands on the traditional site where Romulus was believed to have undergone apotheosis [Coarelli 2014]. Within this symbolic framework, the Pantheon functions as a site of correspondence between mortal Romans and the divine heavens.
As noted earlier, the latent form of the cone manifests itself in the Pantheon by means of the spatial configuration between observer and oculus [1]. However, this is not the only instance of the cone implied by the building's architecture. Indeed, the invisible presence of the cone is to be found everywhere throughout the structure (figs. 8, 9). For example, the relieving arches within the thick walls of the rotunda, curving in three dimensions given the radial construction of the building, delineate a form that can be extended as cones directed towards the center.

## Stereographic projection

Another invisible cone reveals itself through examination of the Pantheon's coffering, which has been the subject of much scholarly debate over centuries. While the nested, apparently rectangular indentations on the dome present as rather uncomplicated, this appearance of simplicity is contradicted by in-depth measurements, such as that carried out in 2006 by the Bern Digital Pantheon Project and later in 2015 by architect Mauro Saccone [see: Graßhoffet al. 2009; Saccone 2017].
The coffering has been formed in such a way as to appear to the viewer on the floor of the Pantheon as a series of concentric squares, diminishing regularly in size. Additionally, the design of the coffering allows the central field of each coffer to remain visible to the viewer wherever they may be on the floor of the rotunda. The regular diminution and orthogonal appearance of the coffering is, however, an optical illusion, as the hemispherical nature of the dome requires a warping of these regular geometric shapes to preserve the appearance of regularity [Fernández-Cabo 2013, p. 543]. This is comparable to the way in which columns are sculpted using entasis, as in the case of the Parthenon, for example, so that they appear perfectly straight [2].
While the exact method employed by the builders of the Pantheon to design the coffering has not been precisely identified, there is a strong case to be made for the use of stereographic projection. This technique, first theorized in the context of the Pantheon by Maria Teresa Bartoli in 1995 [Bartoli 1995], involves mapping a two-dimensional, circular design onto a three-dimensional sphere. Once the two-dimensional design has been completed, it is projected from a point at the antipode of the sphere, i.e. the center of projection. In the case of the Pantheon, the center of projection is below the floor of the building [Saccone 2017, pp. 268-272]. This geometric operation was known at the time of the Pantheon's construction, having been detailed by the second-century CE astronomer and mathematician Claudius Ptolemy [Radojevic 2018, p. 8].
A recent hypothesis made Yuhao Jiang, whilst performing a geometric analysis of the Pantheon on behalf of Kristin Jones' *Oculus* project, strengthens the case for the use of this technique. From this analysis a numerical correspondence emerges that links the process of stereographic projection to the diameter of the oculus. Given a sphere, this geometric operation posits a cone of projection, with its vertex originating from an antipode (fig. 10). The cone intersects the equator of the sphere and is extended to the top of the sphere. The resulting large circle, which is the base of the cone of projection, is tangent to the sphere at the antipode opposite the point of projection and will have a diameter of exactly twice that of the sphere. This mapping technique would have allowed the design of the Pantheon's coffering to be laid out in two dimensions, as it would present itself to a theoretical viewer looking up from the point of projection.

With regard to the full-scale drawings, it is interesting to note that a full-scale drawing of profiles for the portico elevation exist etched into the limestone paving in front of Mausoleum of Augustus [Haselberger 1995, fig. 1], no more than 600 meters from the Rotunda.
To create the design of five rows of twenty-eight coffers, this involves dividing the circle "by 28 meridians and enrolling the first circle tangent to the two meridians and the maximum parallel circle, which determines the next parallel's radius. The next circle is tangent on a new parallel and the two meridians and so on" [Radojevic 2018, p. 8].
However, the "maximum parallel circle" mentioned by Radojevic, used to generate the Pantheon's coffering, is not identical with the circle that forms the base of the cone of projection which intersects the rotunda's equator. Rather, to preserve the visibility of the coffers for the viewer standing on the floor of the rotunda, the design is higher than the edge of the larger circle, corresponding to a cone of projection that intersects the sphere of the rotunda slightly above the equator.
This larger circle, while not directly used to generate the design of the coffering, nevertheless provides the key to the discovery made by Kristin Jones and Yihao Jiang. Extending the 28 meridians used to generate the design of the coffering to the full diameter of the larger circle, a smaller circle can be inscribed, tangent to two meridians and the larger circle, in the same process that was used to generate the coffering. This smaller circle, indicated in figures 10 and 11, corresponds directly to the diameter of the oculus.
This correspondence corroborates the proposed theory that stereographic projection was used to design the layout of the dome's coffering. The application was developed for the purposes of mapping the heavens as well as the earth by the astronomer Claudius Ptolemy (c. 100-170), whose life was roughly contemporary with the construction of the Hadrianic Pantheon. While it is perhaps impossible to determine definitively whether this technique was used, Jones and Jiang's findings, as clearly diagramed in figures 10 and 11, point in this direction, reaffirming the works of Bartoli 1995 and Radojevic 2018 and broadening their application of stereographic projection to include consideration of the precise diameter of the oculus.
It should be stressed that other correspondences concerning the dimensions of the oculus have been noted by multiple scholars of the Pantheon. Gert Sperling, in his 1999 monograph on the building notes that the diameter of the oculus is equal to the height of the interior column shafts [Sperling 1999, p. 122]. Additionally, many have identified the diameter of the oculus as one fifth that of the dome [Fernández-Cabo 2013, p. 534].
Both of these correspondences accord well with the principle of *symmetria*. The width of the oculus and the height of the interior column shafts, along with that of the attic story, equate to 30 Roman feet, a measure one fifth that of the diameter of the generative circle of the building at 150 Roman feet. Rather than fixate on individual correspondences between specific measures, the harmony produced by the application of symmetria should be appreciated with reference to the whole.

## Other considerations

Given the multiple measurements of the building across time, and accounting for the subsidence and acceptable deviation of the actual building from its ideal, planned form, there is a degree to which "exact correspondences" may be less than exact. Many such correspondences may be found within this margin of error. There is also the problem of knowing what intentions lay in the mind of the designers when determining distances between architectural elements. For example, should measurements of distance be calculated from the center or edge of the columns? How are we to know which of these were employed in the building's construction [3]?
This is not meant to discount these findings, but to highlight the fact that individual discoveries must be taken cum grano salis. Nevertheless, the various possible connections that the oculus has to other aspects of the building's design indicates the inexhaustibility of the Pantheon as an object of study. This work of ancient grandeur has captured the minds of countless scholars throughout the centuries, and they continue to mine its depths to better understand the wonder of its geometry.

## The finite and the infinite

Given the enigmatic nature of the Pantheon's design and function, as well as the centrality and importance

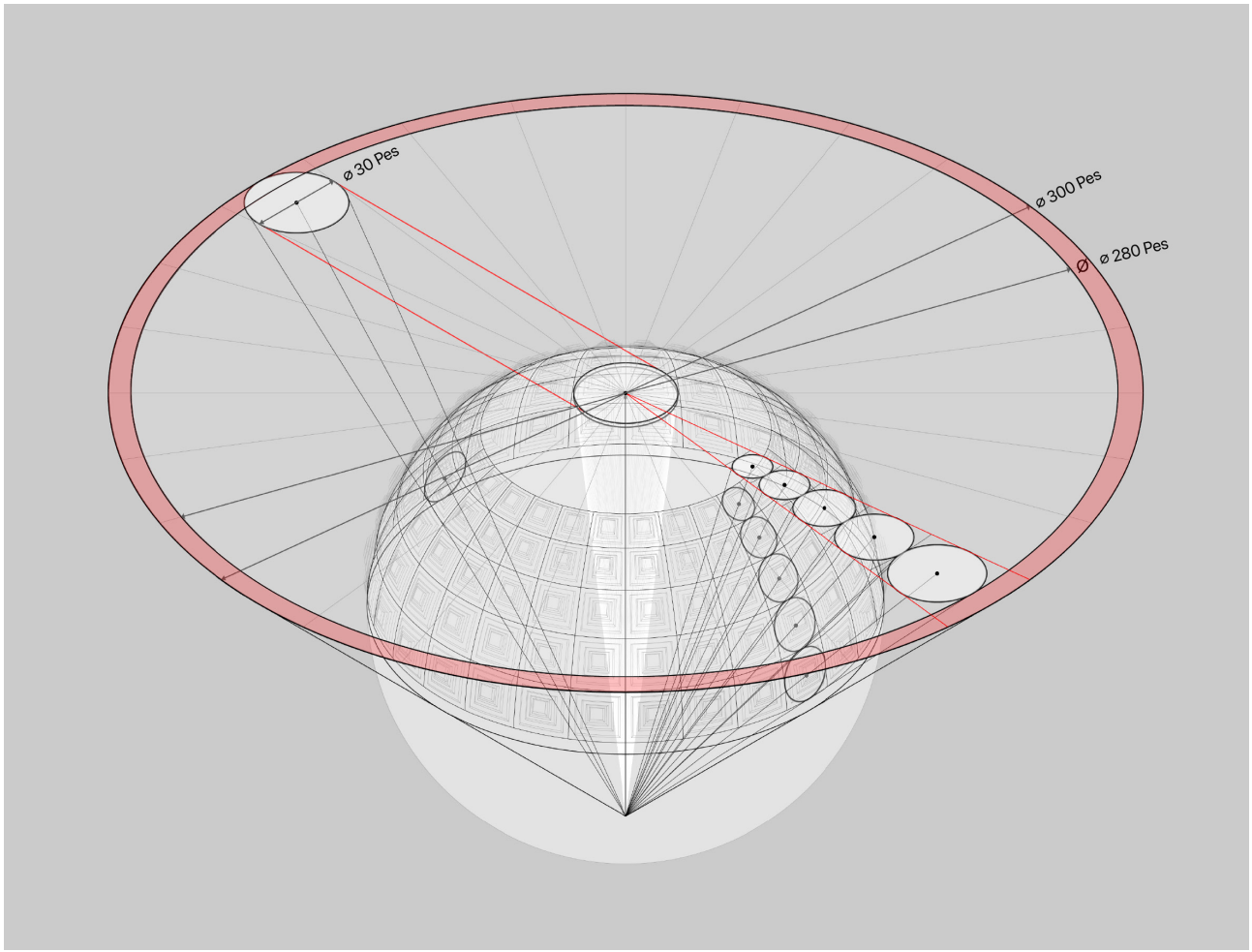
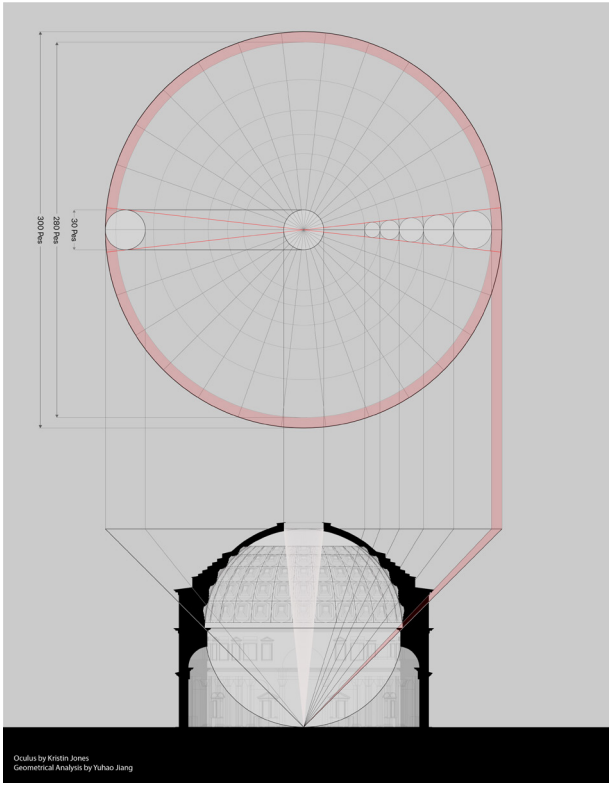



*Fig. 10. Axonometric diagram, showing the dimension of the oculus as generated by stereographic projection (drawing by Yuhao Jiang for Kristin Jones Studio).*

of the oculus within the plan of the building, it seems likely that its dimensions would correspond to multiple other aspects of the design. The oculus is the point of contact between the microcosm and the macrocosm. By bringing the light of the sun into the otherwise shadowy interior of the building, the oculus may be understood experientially as a point of contact between the realm of the heavenly bodies and the mundane world of the everyday. As Eugenio La Rocca writes in The Pantheon: From Antiquity to the Present: "The oculus in the dome presented that union of earth and sky that symbolized an apotheosis into the heavens" [La Rocca 2015, p. 76].
This aspect of the Pantheon as the link between finite and infinite, between mortal being and immortal cosmos, is distilled in the geometry of the cone. As a geometric figure, the cone connects the finitude of the single point with the relative infinity of the circle. In our vision, the cone is the form in which light reaches us. It underlies the entirety of our visual experience, which is one of the primary ways we encounter the world beyond. In this sense, the cone, like the Pantheon itself, may be understood as emblematic of the relationship between the microcosm and the macrocosm. The implied presence of this invisible geometry within the space of the building, therefore, provides a unique lens through which to understand the elegant symbolism of this ancient wonder (figs. 13-15).




| Roman unit | English name | Metric equivalent | Imperial equivalent |
|---|---|---|---|
| Pes | (Roman) foot | 0,296 m | 0,971 ft |
| Passus | Pace | 1.48 m | 4.854 ft |

**Credits**

This article is a collective work by Kristin Jones Studio, with contributions from Nate Sloan, Yuhao Jiang, Caleb Skene, and Brooklyn Richardson.
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*Fig. 11. Plan and Section Diagram of stereographic projection in the Pantheon (drawing by Yuhao Jiang for Kristin Jones Studio).*

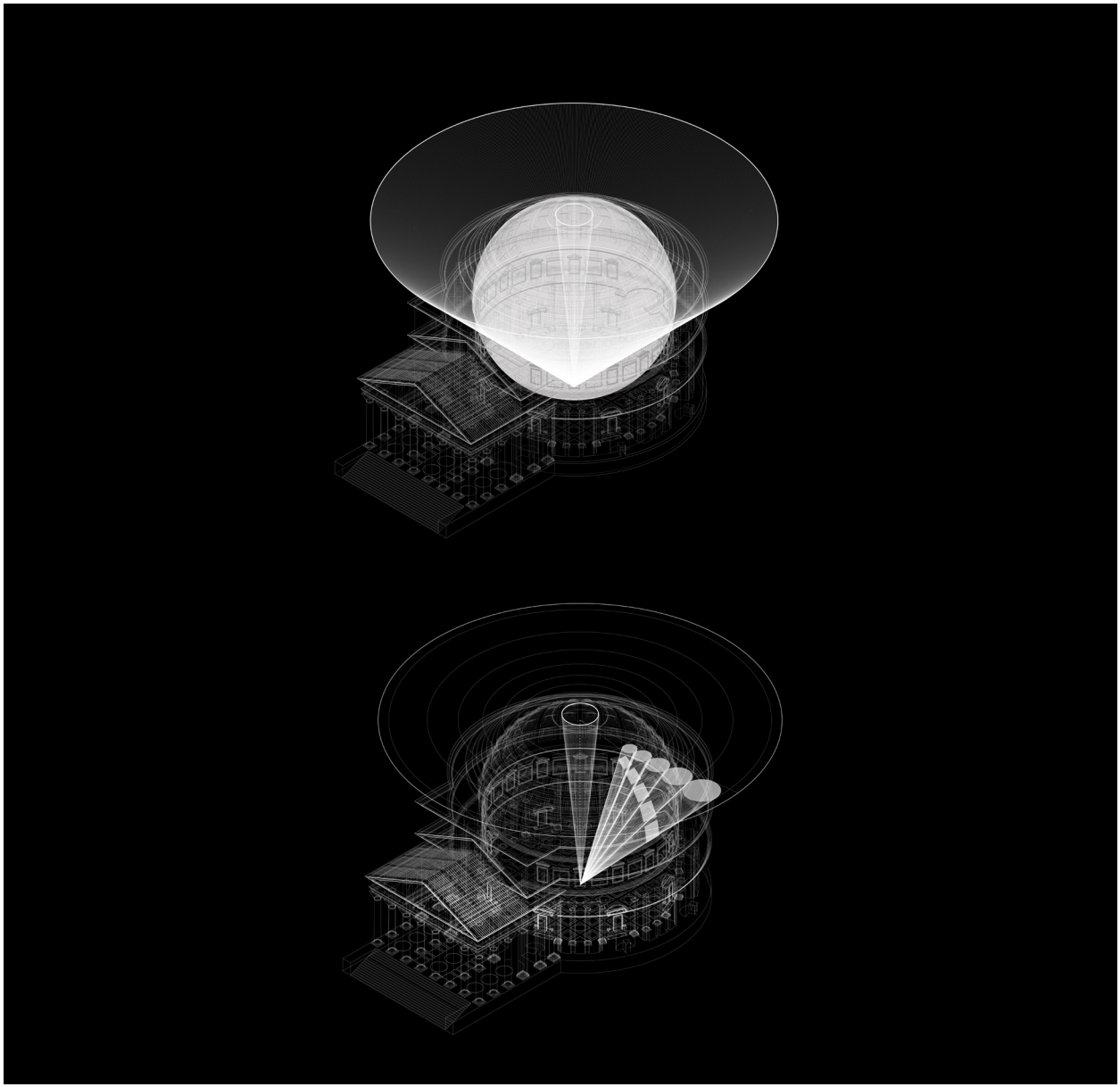

*Fig. 12. Diagram of the stereographic projection cones (drawing by Caleb Skene and Yuhao Jiang, 2025).*

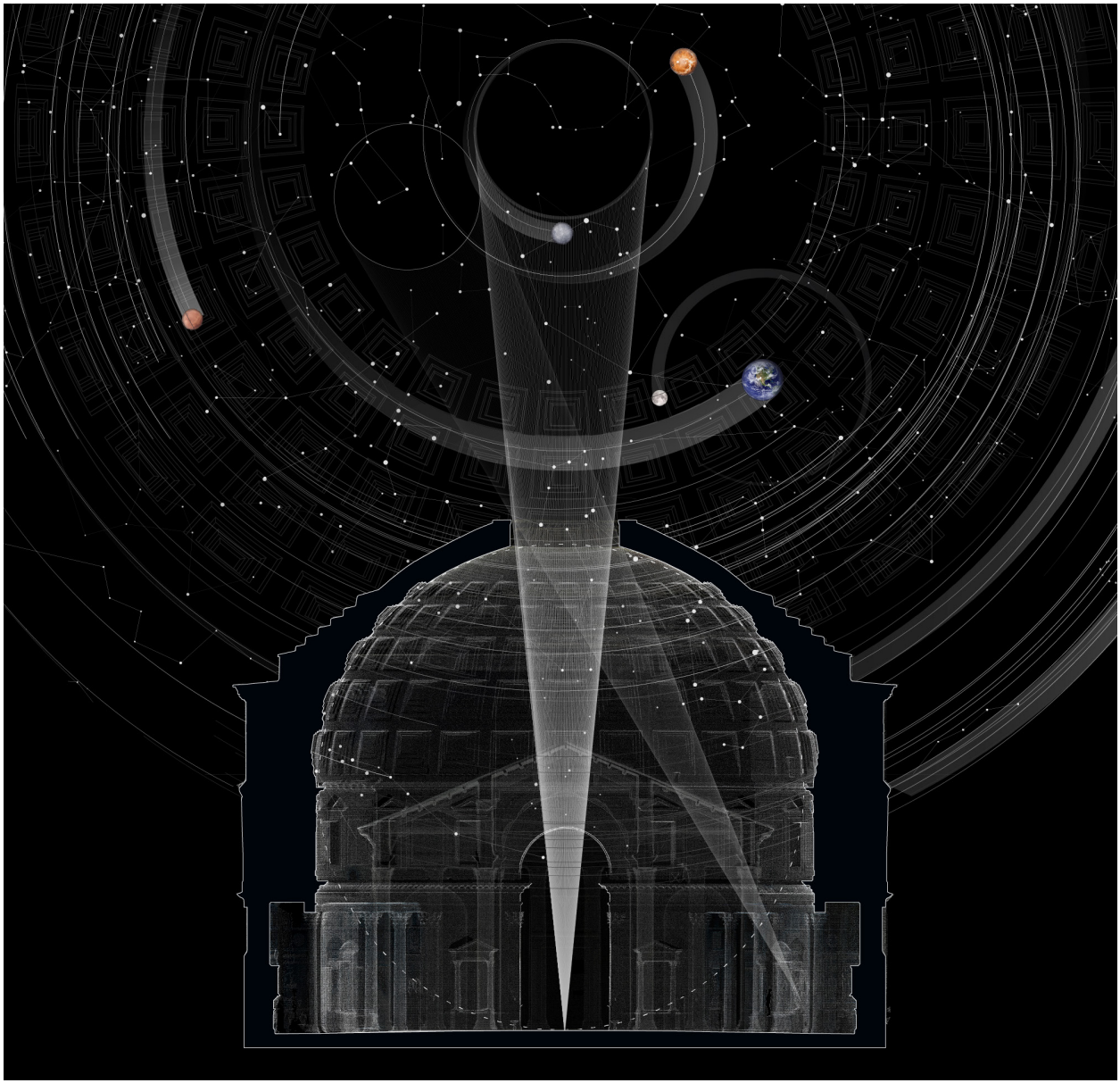

*Fig. 13. Diagram of the Pantheon as a link between the finite and the infinite. Drawn by Brooklyn Richardson for Kristin Jones Studio.*

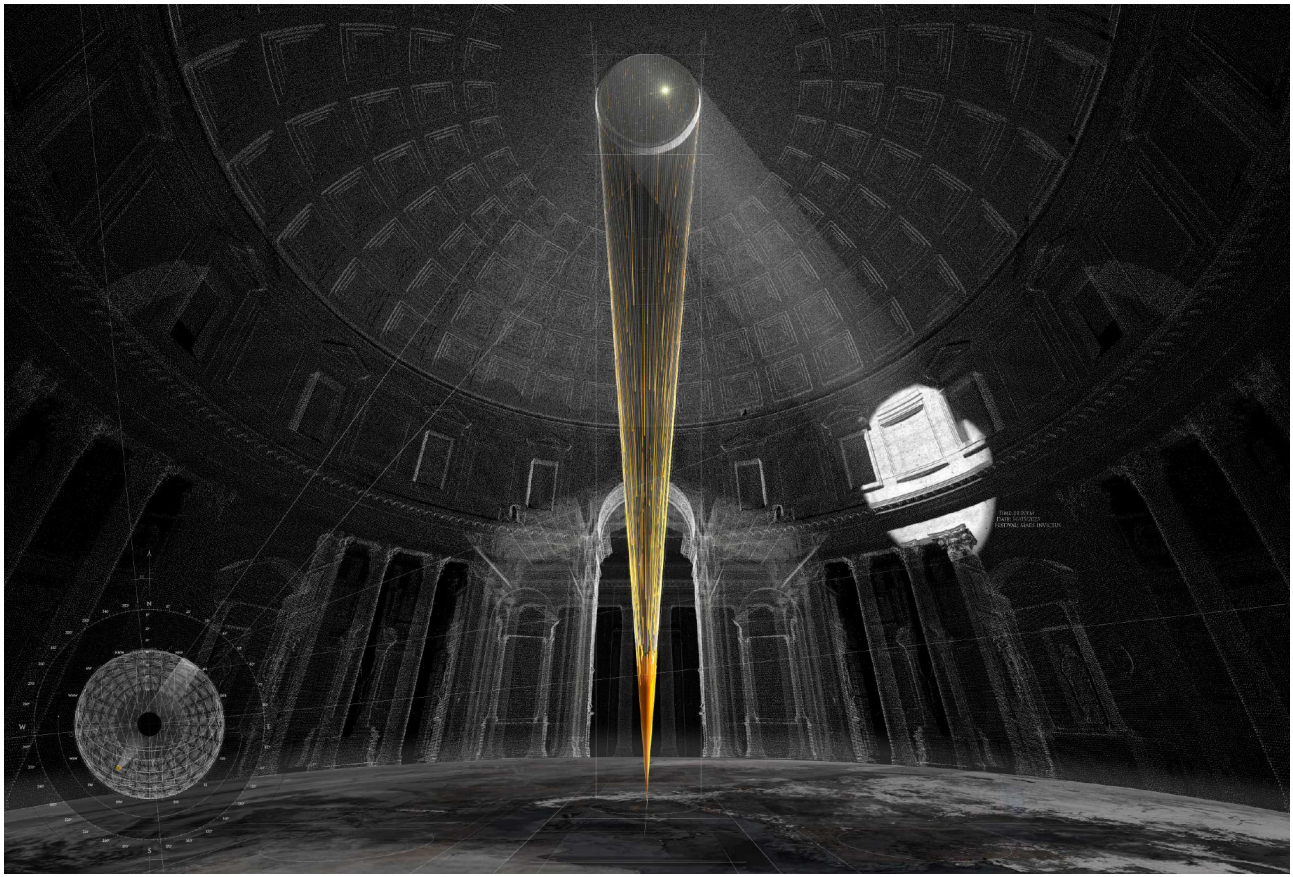

*Fig. 14. Mars Invictus, interior view of a moment in time (May 15th) with domed floor and diagram of reflected ceiling plan, showing the position of the sun (drawing by Caleb Skene for Kristin Jones Studio).*

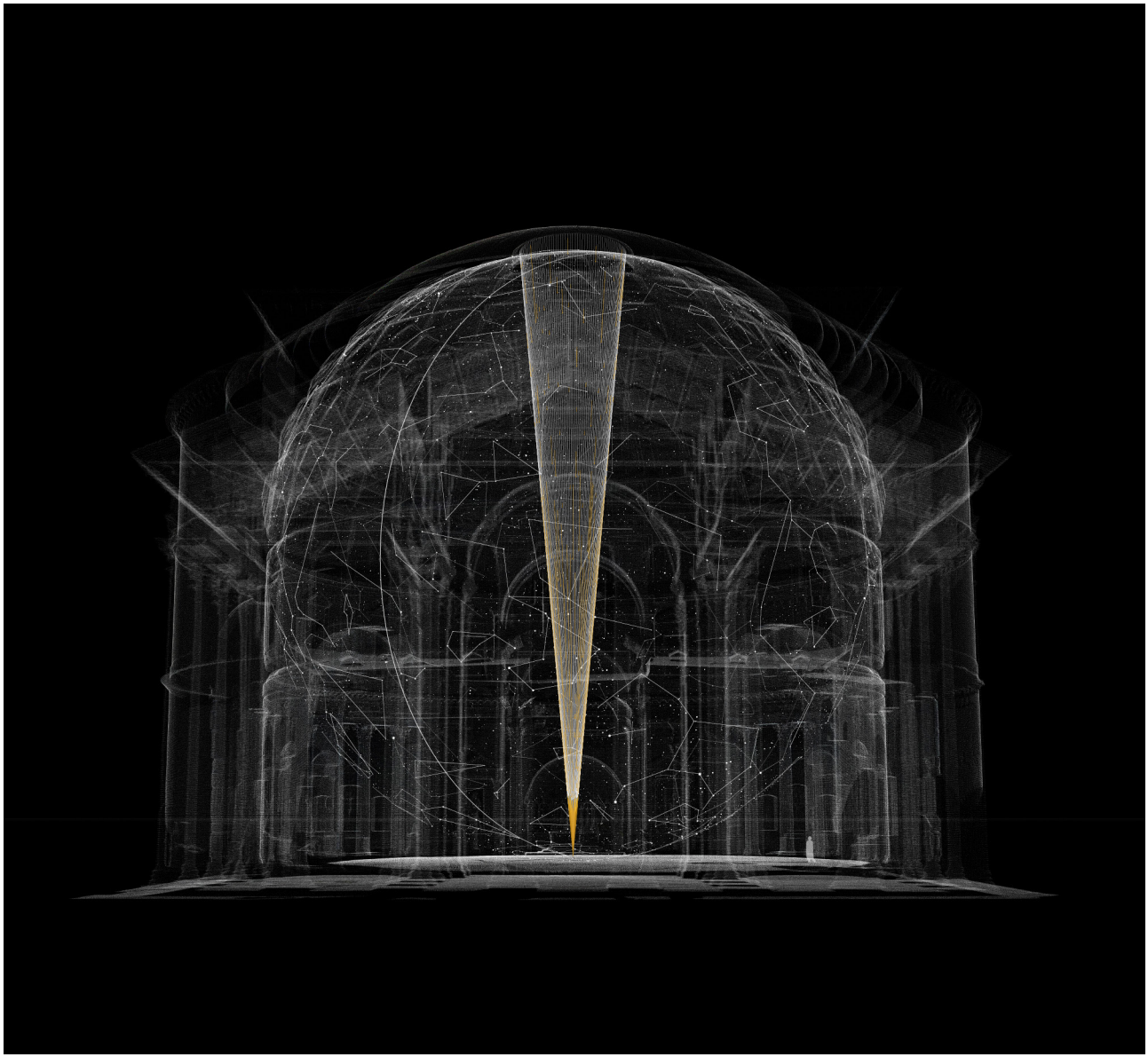

*Fig. 15. Vessel of the Cosmos, composition of an approx. 20million LiDAR point model of the Pantheon, with oculus cone and approx.. 9,000-star celestial sphere. Drawn by Brooklyn Richardson for Kristin Jones Studio.*

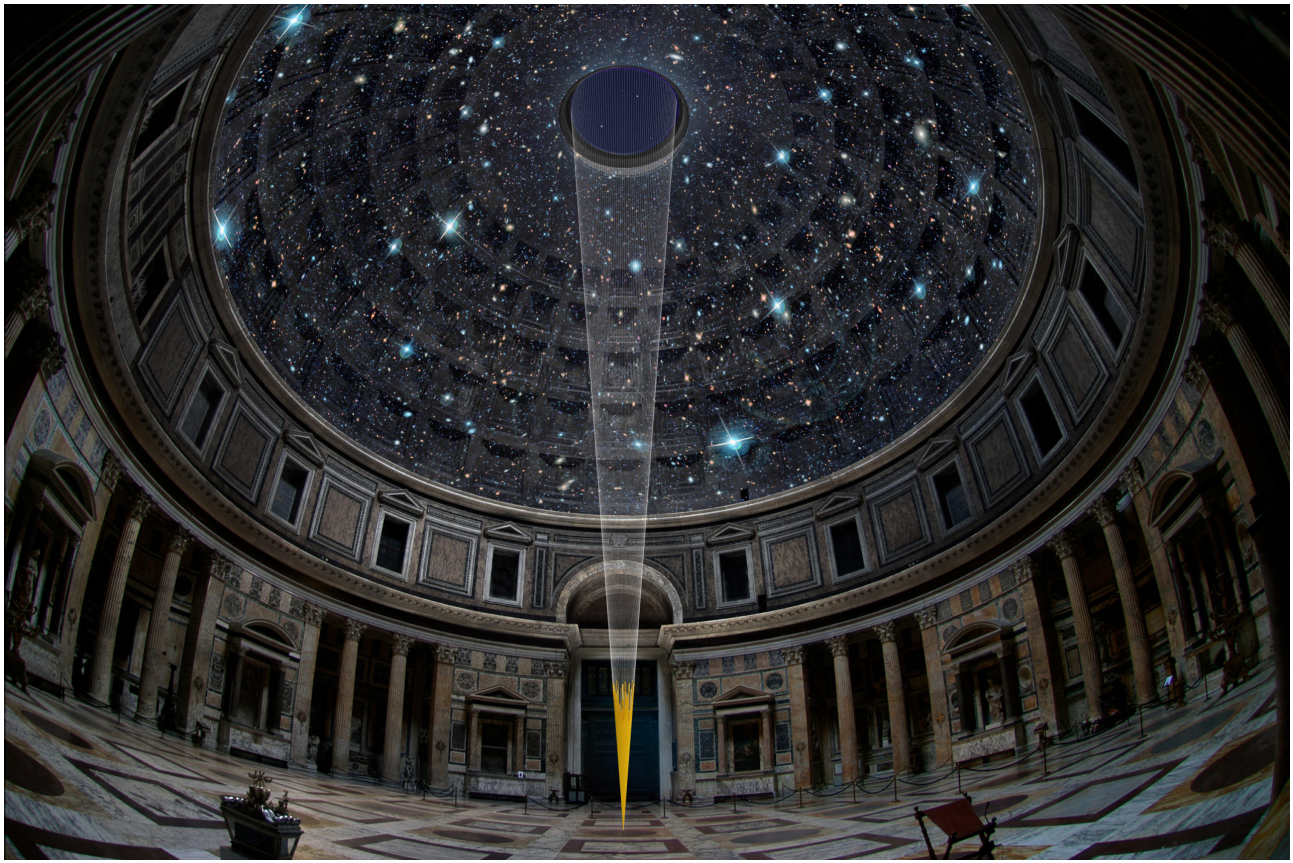

*Fig. 16. OCULUS. Nighttime view from altar (rendering). Installation composed of three elements: cone form, projection and sound. Cone of thread envisioned by Kristin Jones descends 150 feet from the 30-foot oculus. The projection is a Deep Field image, including over 300,000 distant galaxies, millions to many billions of light-years away, composed by Michael Benson from digital images collected with the CFHT telescope between 2003-2009.*

*Fig. 17. OCULUS. Daytime view from altar. Concept and Art Direction: Kristin Jones. Original Image: Marcello Melis. Geometric Analysis and Drawing: Yuhao Jiang.*

## Notes

[1] It should be stressed that while the geometric configurations described above are all cones, they differ in their specific aspects of height, apex etc.

[2] Entasis is an optical device by which the shaft of a column is sculpted so that its vertical profile appears slightly convex. If sculpted perfectly straight, the column would appear to diminish in width at its midpoint. Entasis serves to correct this illusion. It should be noted, however, that in some cases its use extends well beyond the correction of an optical illusion and is motivated by its intrinsic aesthetic value: see Jones 1999.

[3] This problem, at play in all the Romans' radial buildings, is explored more fully in Jones 1989, pp. 106-151.

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